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Basic Radio Propagation Predictions

FOR SEPTEMBER 1948

Three Months in Advance

Issued June 1948

CRPL Series D Number 46

The Central Radio Propagation Laboratory

The propagation of radio waves over long distances depends on their reflection from the ionosphere, the electrically conducting layers in the earth's upper atmosphere. The characteristics of these layers are continuously changing. For regular and reliable communication, it is therefore necessary to collect and analyze ionospheric data from stations all over the world in order that predictions of usable frequencies between any two places at any hour can be made. During the war, the United States Joint Communications Board set up the Interservice Radio Propagation Laboratory at the National Bureau of Standards to centralize ionospheric work and predictions for the Armed Forces of the United States.

On May 1, 1946, this activity returned to peacetime status as the Central Radio Propagation Laboratory of the National Bureau of Standards. Designed to act as a permanent centralizing agency for propagation predictions and studies, analogous in the field of radio to the reports of the Weather Bureau in the field of meteorology, the Central Radio Propagation Laboratory was established in cooperation with the many Government agencies vitally concerned with communication and radio propagation problems. These agencies are represented on an Executive Council which guides the work of the Laboratory; included are the Department of the Army, Department of the Navy, Department of the Air Force, Civil Aeronautics Administration, Federal Communications Commission, Department of State, Coast Guard, Coast and Geodetic Survey, and the Weather Bureau. In addition, industry is represented by the Radio Technical Planning Board, while the Carnegie Institution of Washington serves in an advisory capacity and the Research and Development Board has designated an observer.

The Central Radio Propagation Laboratory receives and analyzes data from approximately 60 stations located throughout the world, including 13 domestic and 8 overseas stations which are operated either directly or under contract by the National Bureau of Standards. Ionospheric data and predictions are disseminated to the armed forces, commercial users, scientists, and laboratories. The basic ionospheric research of the Laboratory includes theoretical and experimental studies of maximum usable frequencies, ionospheric absorption, long-time variations of radio propagation characteristics, the effects of the sun on radio propagation, and the relation between radio disturbance and geomagnetic variation. In the microwave field, the Laboratory is investigating the relation between radio propagation and weather phenomena, as well as methods by which predictions can be made and radio communications improved in this portion of the radio-frequency spectrum. Another phase of the Laboratory's work is the development and maintenance of standards and methods of measurement of many basic electrical quantities throughout the entire frequency spectrum.

Basic Radio Propagation Predictions

The CRPL Series D, Basic Radio Propagation Predictions, is issued monthly as an aid in the determination of the best sky-wave frequencies over any path at any time of day for average conditions for the month of prediction, 3 months in advance. Charts of extraordinary-wave critical frequency for the $F2$ layer, of maximum usable frequency for a transmission distance of 4,000 km, and of percentage of time occurrence for transmission by sporadic E in excess of 15 Mc, for a distance of 2,000 km, are included.

Beginning with the July 1946 issue (CRPL–D23) the CRPL–D series, "Basic Radio Propagation Predictions," is available on a purchase basis from the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C., on the following terms:

Single copy	10 cents
(CRPL–D23 through D36, 15 cents per copy)	
Annual subscription (12 issues)	$1. 00
(To foreign countries not extending franking privileges, $1. 25)	

The rules of the Superintendent of Documents require that remittances be made in advance, either by coupons sold in sets of 20 for $1 and good until used, or by check or money order payable to the Superintendent of Documents. Currency, if used, is at sender's risk. Postage stamps, foreign money, and defaced or smooth coins are not acceptable. Postage is not required in the United States, to United States possessions, and to countries extending franking privileges. Remittances from foreign countries should be by international money order payable to the Superintendent of Documents or by draft on an American bank.

Address subscriptions, remittances, and all inquiries relating thereto, to the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C.

[Published with approval of the Director of the Budget]

U. S. DEPARTMENT OF COMMERCE
Charles Sawyer, Secretary
NATIONAL BUREAU OF STANDARDS
E. U. Condon, Director

June 1948
CRPL Series D
Number 46

BASIC RADIO PROPAGATION PREDICTIONS

For September 1948 — Three Months in Advance

Introduction

Beginning with the September 1947 issue, the CRPL–D series, "Basic Radio Propagation Predictions," issued by the National Bureau of Standards, contains contour charts of $F2$-zero-muf and $F2$-4000-muf for each of the three zones, W, I, and E, into which the world is divided for the purpose of taking into consideration the variation of the characteristics of the $F2$-layer with longitude (figs. 1 to 6); the world-wide contour chart of E-layer 2000-muf (fig. 7); the contour chart of median fEs (fig. 8); and the chart showing percentage of time occurrence for Es-2000-muf in excess of 15 Mc (fig. 9).

Methods for using these charts are given in Circular 465 of the National Bureau of Standards, entitled "Instructions for the Use of Basic Radio Propagation Predictions," and available from the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C., price 25 cents. Requests for this manual from members of the Army or Navy should be sent to the proper service address as follows. *For the Army:* Office of the Chief Signal Officer, Department of the Army, Washington 25, D. C., Attention: SIGOL–2. *For the Navy:* Chief of Naval Operations, Department of the Navy, Washington 25, D. C. (CNC–20–Q).

Following figure 9 of each issue, sets of auxiliary figures (nos. 1, 2, 11, 12, NBS Circular 465) or forms CRPL–AF and AH are given in rotation, two in each issue of CRPL Series D. They are necessary or useful for the preparation of tables and graphs of muf and owf, as explained in NBS Circular 465.

The charts in this issue were constructed from data through March 1948, together with a predicted smoothed 12-month running-average Zürich sunspot number of 117, centered on September 1948.

Attention is invited to the blank form at the end of this publication, for use in reporting the accuracy of the predictions of muf and owf as given in this report. Communications should be addressed to Central Radio Propagation Laboratory, National Bureau of Standards, Washington 25, D. C.

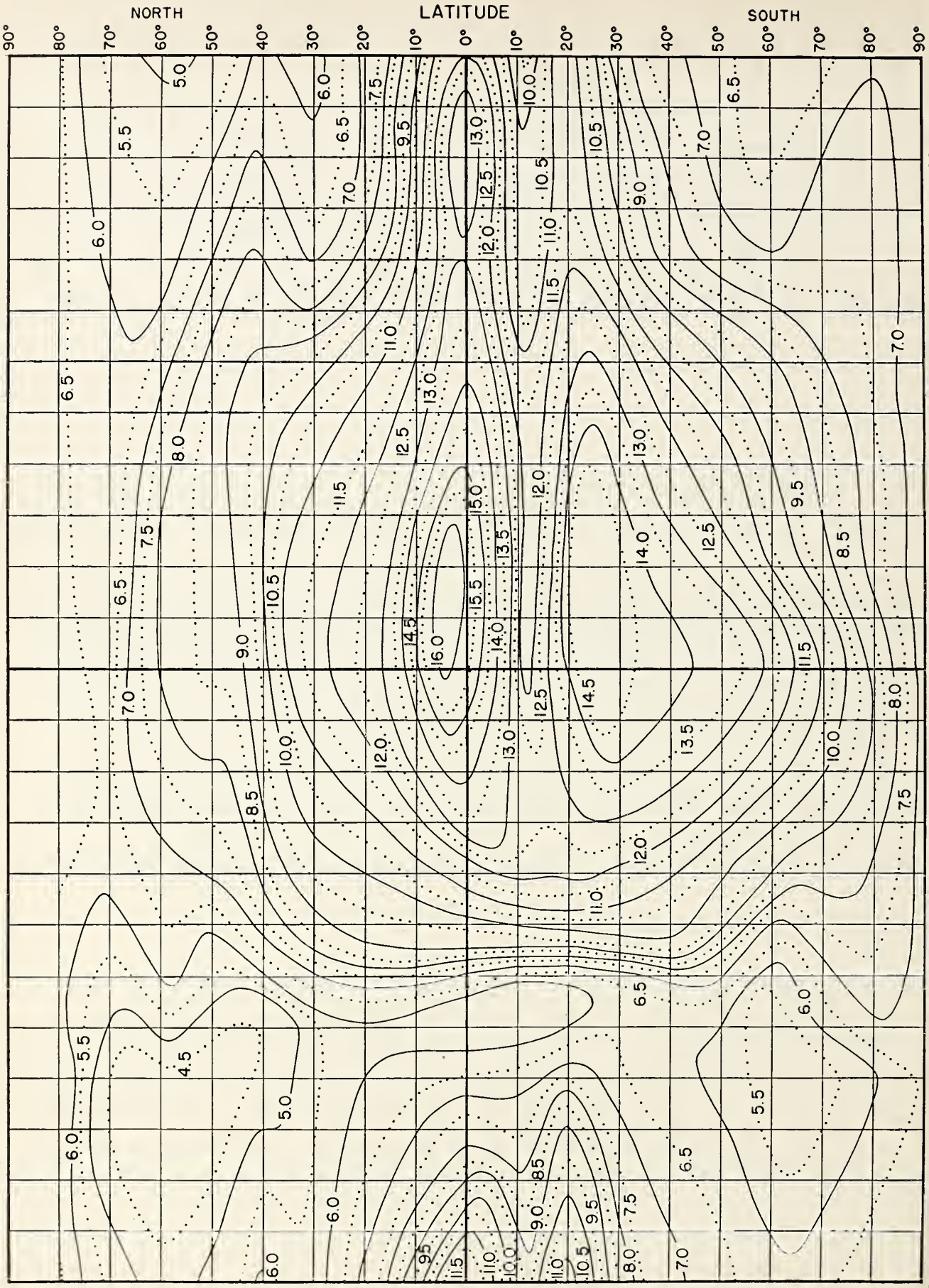

Fig. 1. F_2 ZERO—MUF, IN Mc, W ZONE, PREDICTED FOR SEPTEMBER 1948.

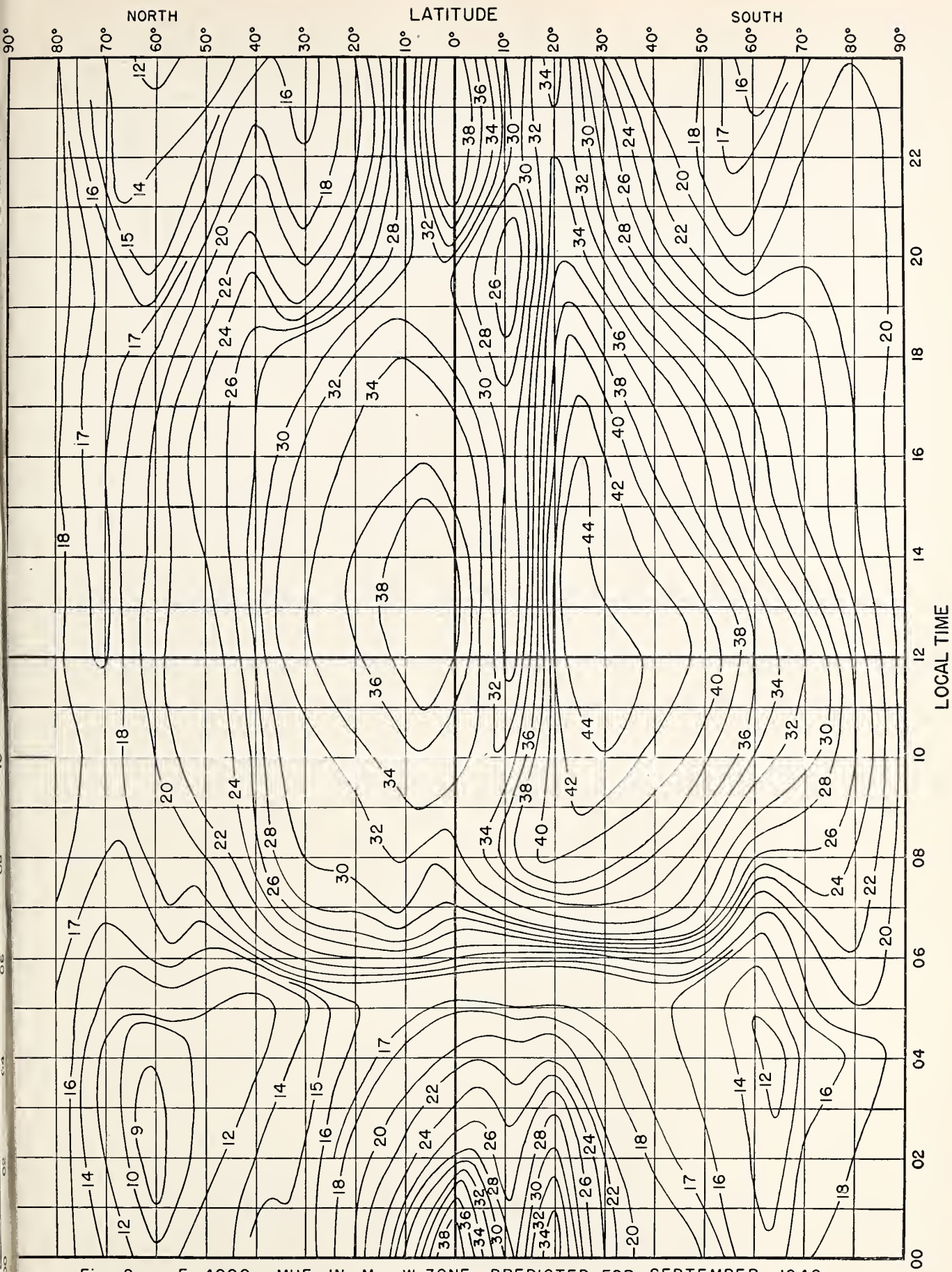

Fig. 2. F_2 4000 — MUF, IN Mc, W ZONE, PREDICTED FOR SEPTEMBER 1948.

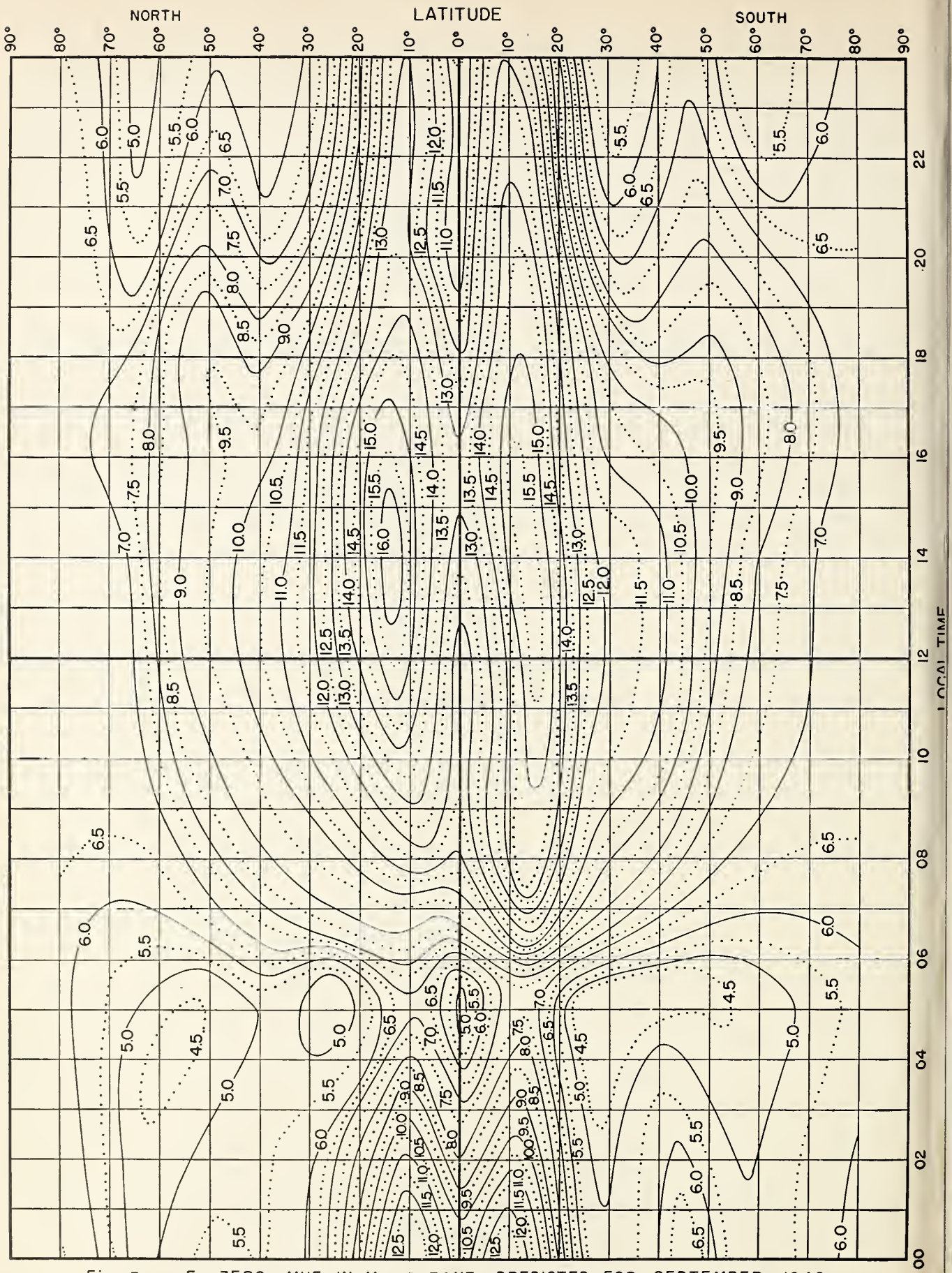

Fig. 3. F_2 ZERO—MUF, IN Mc, I ZONE, PREDICTED FOR SEPTEMBER 1948.

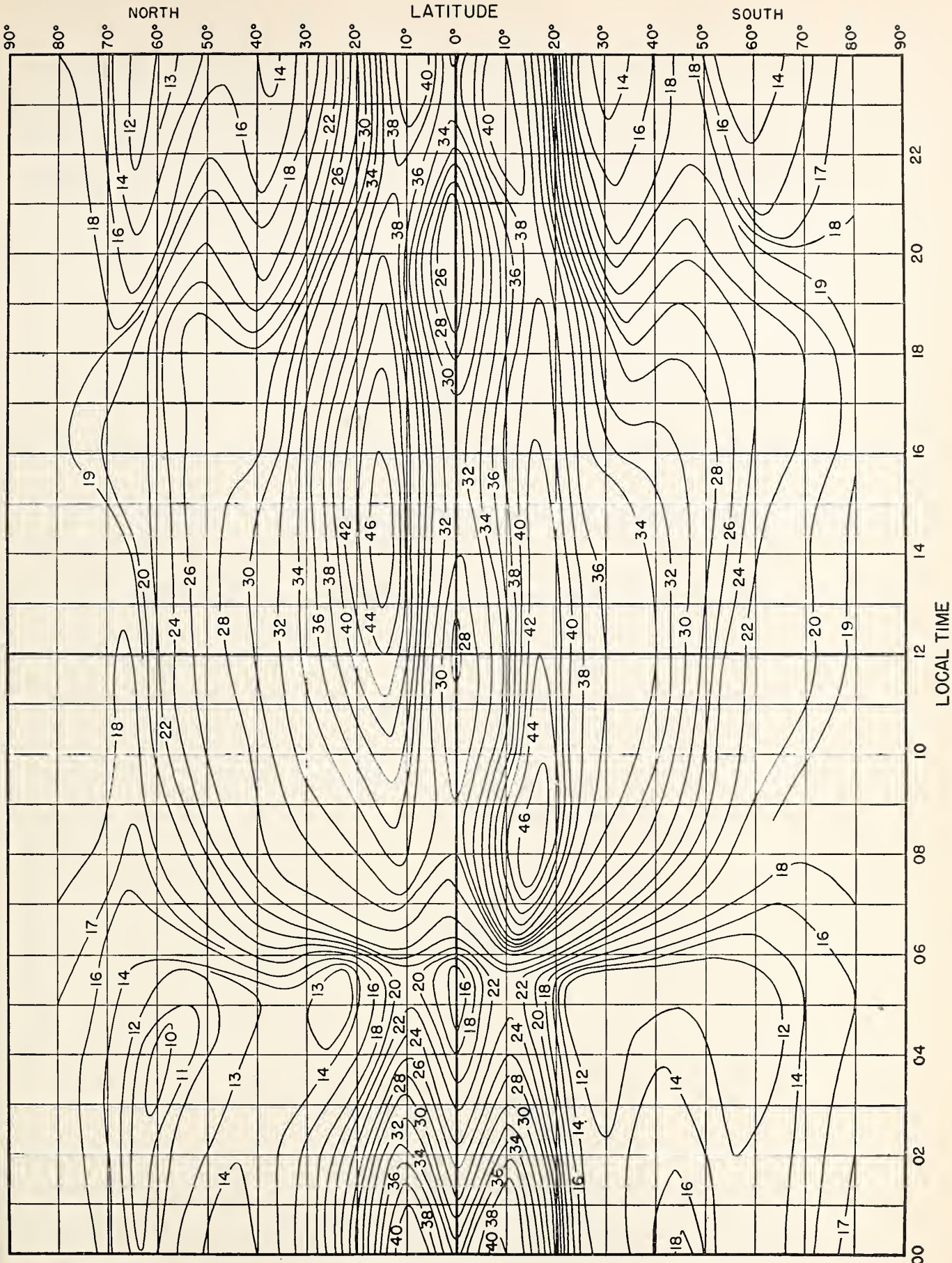

Fig. 4. F_2 4000—MUF, IN Mc, I ZONE, PREDICTED FOR SEPTEMBER 1948.

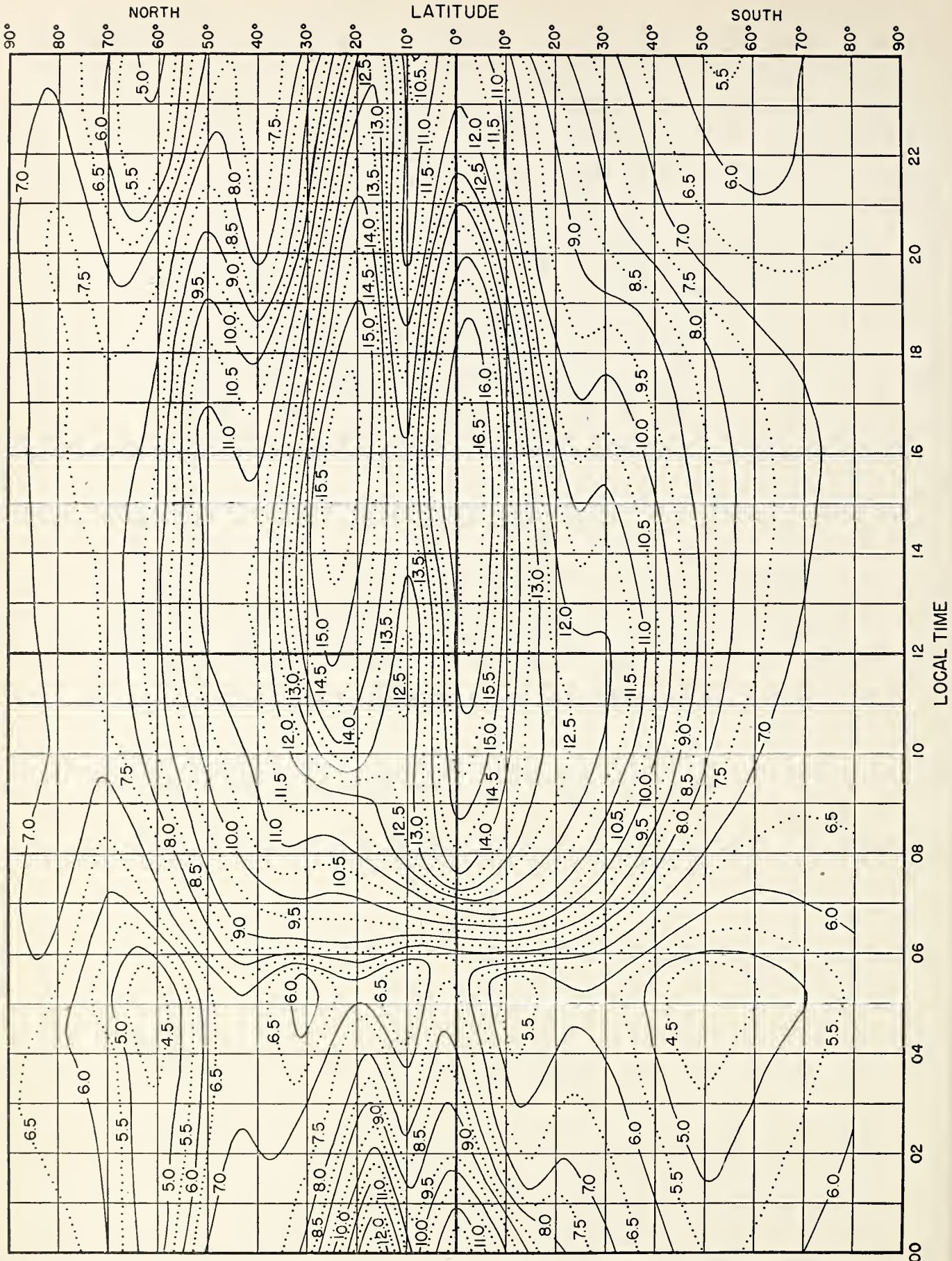

Fig. 5. F_2 ZERO—MUF, IN Mc, E ZONE, PREDICTED FOR SEPTEMBER 1948.

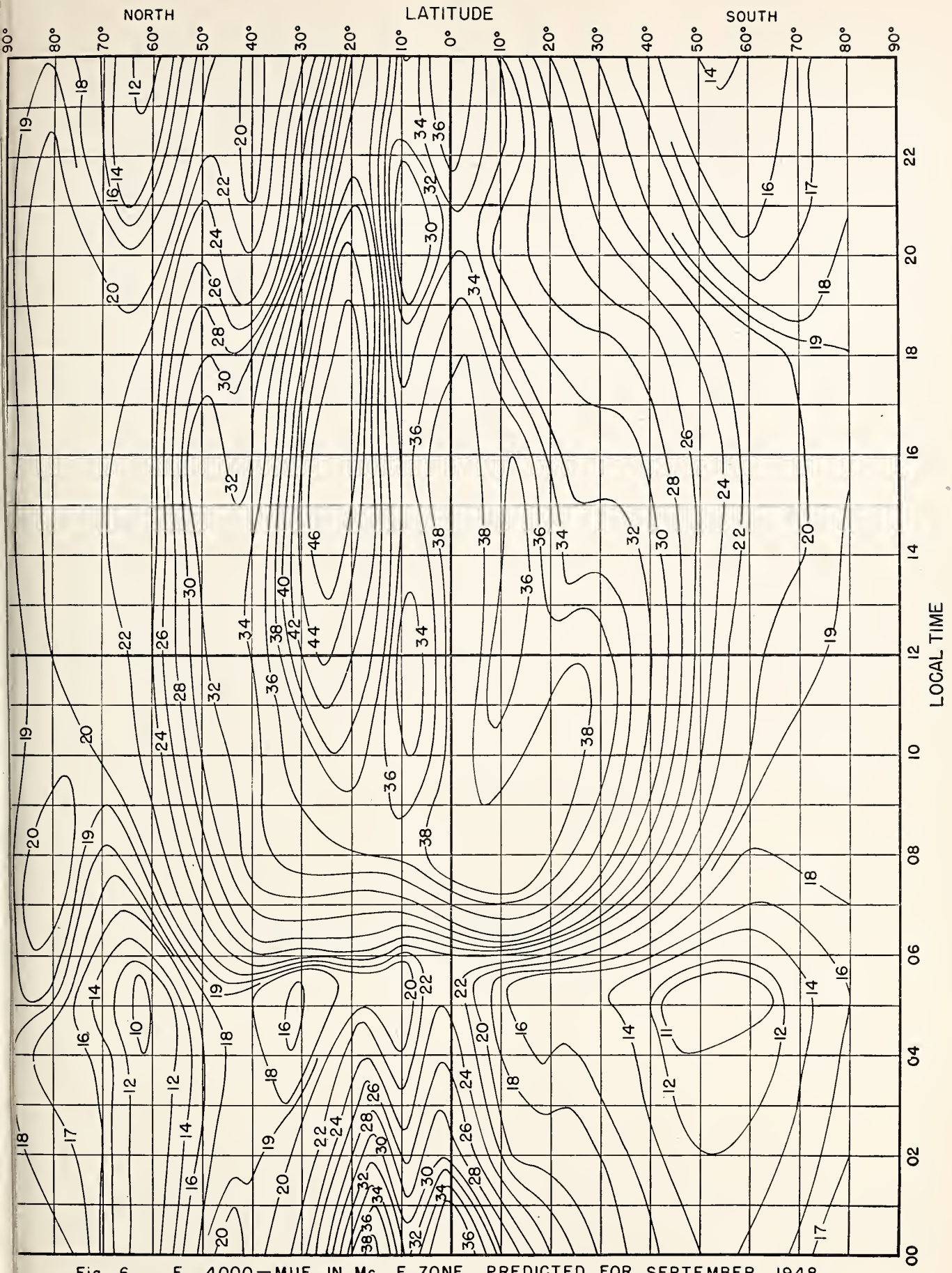

Fig. 6. F_2 4000—MUF, IN Mc, E ZONE, PREDICTED FOR SEPTEMBER 1948.

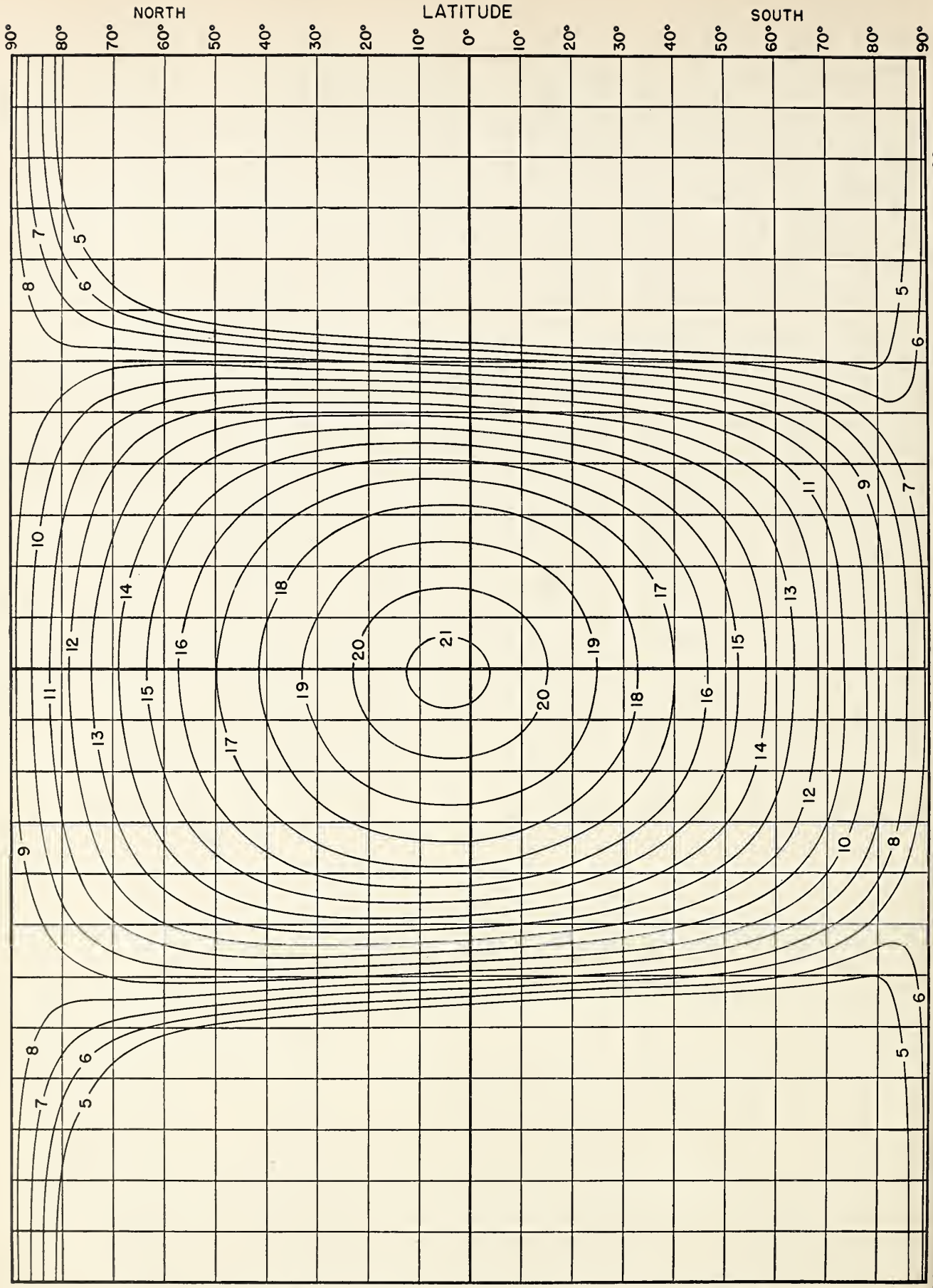

Fig. 7. E—LAYER 2000—MUF, IN Mc, PREDICTED FOR SEPTEMBER 1948.

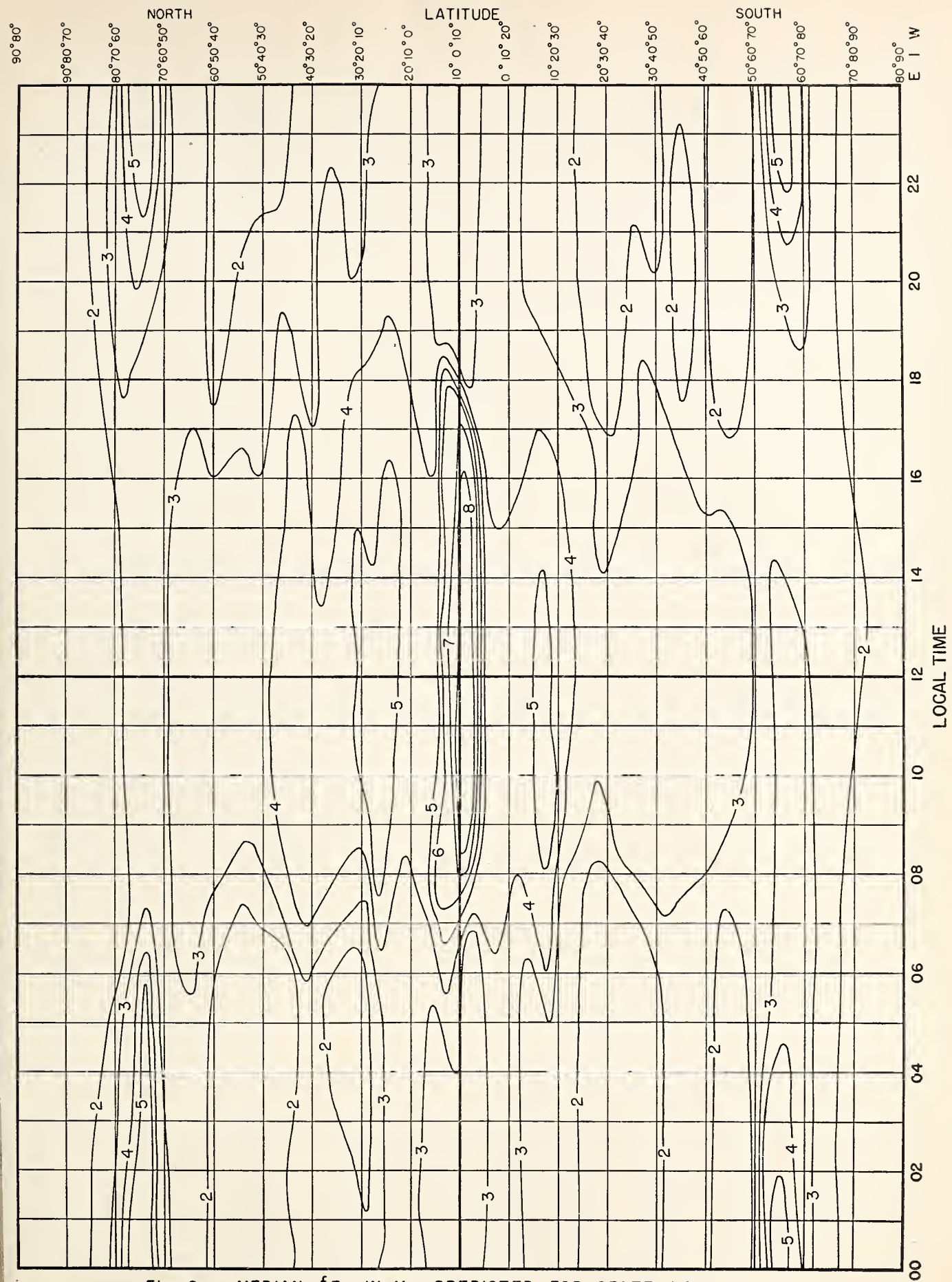

Fig. 8. MEDIAN fE_s, IN Mc, PREDICTED FOR SEPTEMBER 1948.

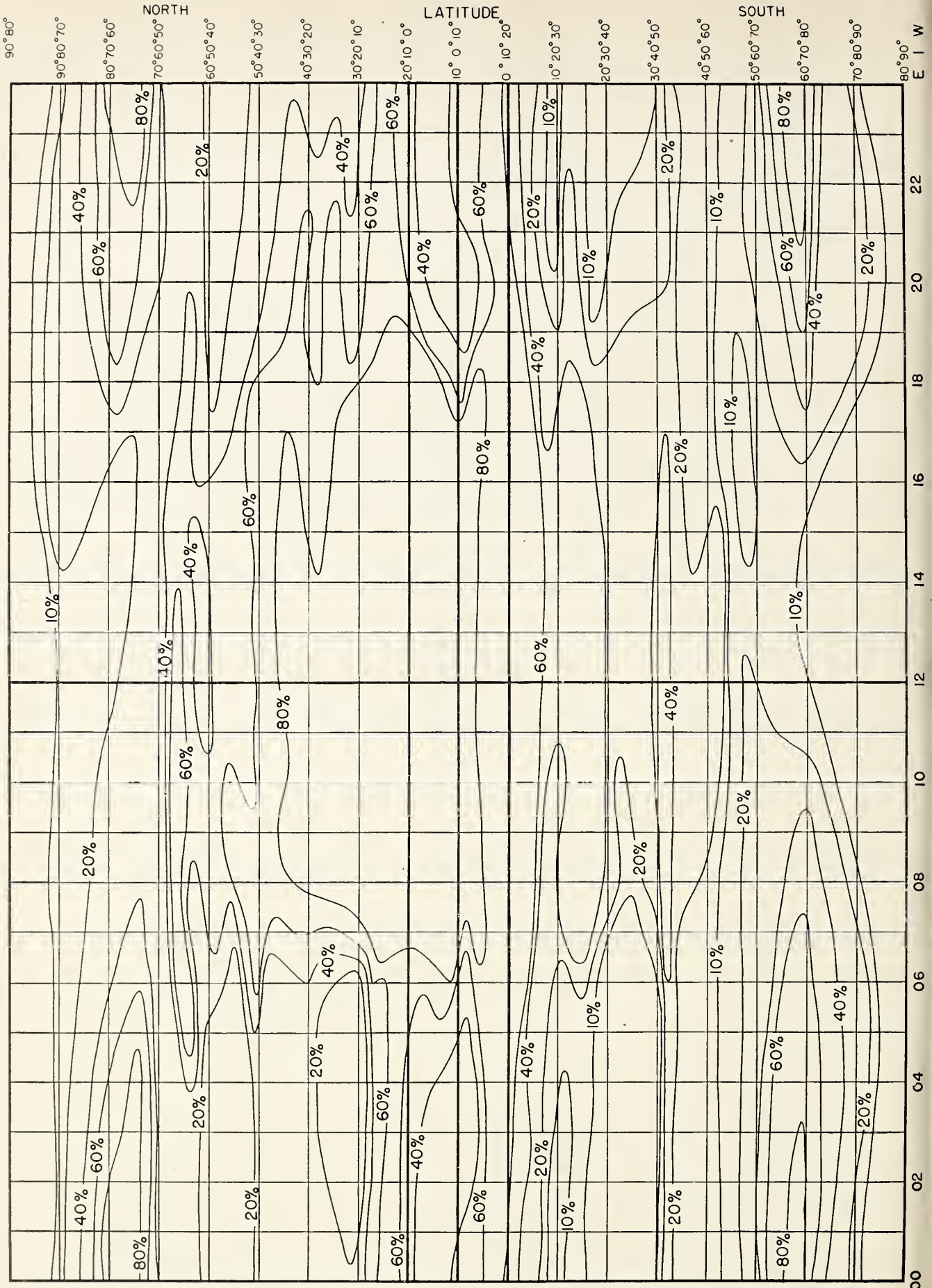

Fig. 9. PERCENTAGE OF TIME OCCURRENCE FOR E_s 2000-MUF IN EXCESS OF 15 Mc, PREDICTED FOR SEPTEMBER 1948.

FORM AF

CRPL

Date _____

MUF-OWF WORK SHEET FOR PATHS 4000 KM OR LESS

From _____ To _____ Distance, _____ km Zone ____ Predicted for ____ 194__

Note: All frequencies are in megacycles.

GCT	f_{E_s}	E_s 2000-muf	E-layer 2000-muf	F_2 zero-muf	F_2 4000-muf	E_s-muf for Path	E-F_1-muf for Path	F_2-muf for Path	E_s 2000-owf	E_s-owf for Path	E-owf for Path	F_2-owf for Path	MUF for Path	OWF for Path
	a	b	c	d	e	f	g	h	i	j	k	l	m	n
Procedure	Scale	5 X a	Scale	Scale	Scale				b-4.0		Same as g	.85 h	Highest of f, g, h	Highest of j, k, l
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23														
Done by														
Checked														

FORM AH

CRPL

Date _____

MUF-OWF WORK SHEET FOR PATHS OVER 4000 KM.

From _____ To _____ Distance, _____ km Predicted for _____ 194__

Note: All frequencies are in megacycles.

	A-end						B-end											
	Pt. A in ____ Zone			Pt. A' in ____ Zone			Pt. B in ____ Zone			Pt. B' in ____ Zone			MUF	MUF	OWF	OWF	MUF for PATH	OWF for PATH
GCT	f_{E_s}	E_s 2000-muf	F_2 4000-muf	E-layer 2000-muf	E_s 2000-owf	F_2 4000-owf	f_{E_s}	E_s 2000-muf	F_2 4000-muf	E-layer 2000-muf	E_s 2000-owf	F_2 4000-owf	A-end	B-end	A-end	B-end		
	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p	q	r
Procedure	Scale pt. A'	5 X o	Scale pt. A	Scale pt. A'	b-4.0	.85 c	Scale pt. B'	5 X g	Scale pt. B	Scale pt. B'	h-4.0	.85 i	Highest of b,c,d	Highest of h,i,j	Highest of d,e,f	Highest of j,k,l	Lower of m,n	Lower of o,p
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(Cut along this line)

Form for Report to CRPL on Accuracy of Predictions

Name _____ Date _____

Address _____ _____ _____ _____ _____ _____
No. Street City P.O. Zone State Country

From (between) _____ to (and) _____ Date _____

Time (specify zone) _____																	
Frequency Used																	
D-Series Predicted OWF (Regular Layers)																	
D-series Predicted OWF (Including Es)																	

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CRPL–7–1. Preliminary Instructions for Obtaining and Reducing Manual Ionospheric Records.
NBS Circular 465. Instructions for the Use of Basic Radio Propagation Predictions.

Reports issued in past:

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IRPL–G1 through G12. Correlation of D. F. Errors With Ionospheric Conditions.
IRPL–R. Nonscheduled reports:
- R4. Methods Used by IRPL for the Prediction of Ionosphere Characteristics and Maximum Usable Frequencies.
- R5. Criteria for Ionospheric Storminess.
- R6. Experimental Studies of Ionospheric Propagation as Applied to the Loran System.
- R7. Second Report on Experimental Studies of Ionospheric Propagation as Applied to the Loran System.
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- R16. Predicted *F*2-layer Frequencies Throughout the Solar Cycle, for Summer, Winter, and Equinox Season.
- R17. Japanese Ionospheric Data—1943.
- R18. Comparison of Geomagnetic Records and North Atlantic Radio Propagation Quality Figures—October 1943 Through May 1945.
- R19. Nomographic Predictions of *F*2-layer Frequencies Throughout the Solar Cycle, for June.
- R20. Nomographic Predictions of *F*2-layer Frequencies Throughout the Solar Cycle, for September.
- R21. Notes on the Preparation of Skip-Distance and MUF Charts for Use by Direction-Finder Stations. (For distances out to 4000 km.)
- R22. Nomographic Predictions of *F*2-layer Frequencies Throughout the Solar Cycle, for December.
- R23. Solar-Cycle Data for Correlation with Radio Propagation Phenomena.
- R24. Relations Between Band Width, Pulse Shape and Usefulness of Pulses in the Loran System.
- R25. The Prediction of Solar Activity as a Basis for the Prediction of Radio Propagation Phenomena.
- R26. The Ionosphere as a Measure of Solar Activity.
- R27. Relationships Between Radio Propagation Disturbance and Central Meridian Passage of Sunspots Grouped by Distance From Center of Disc.
- R28. Nomographic Predictions of *F*2-layer Frequencies Throughout the Solar Cycle, for January.
- R30. Disturbance Rating in Values of IRPL Quality-Figure Scale From A. T. & T. Co. Transmission Disturbance Reports to Replace T. D. Figures as Reported.
- R31. North Atlantic Radio Propagation Disturbances, October 1943 Through October 1945.
- R32. Nomographic Predictions of *F*2-layer Frequencies Throughout the Solar Cycle, for February.
- R33. Ionospheric Data on File at IRPL.
- R34. The Interpretation of Recorded Values of *fEs*.
- R35. Comparison of Percentage of Total Time of Second-Multiple *Es* Reflections and That of *fEs* in Excess of 3 Mc.

IRPL–T. Reports on tropospheric propagation:
- T1. Radar operation and weather. (Superseded by JANP 101.)
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